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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Antony MORTON **Mail Stop PCT**

Appl. No. : Not Yet Assigned (National Phase of PCT/GB2003/004585) **PCT Branch**

I.A. Filed : October 24, 2003

For : CONDENSATION DRYER FABRIC

**CLAIM OF PRIORITY**

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Commissioner for Patents
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Sir:

Applicant hereby claims the right of priority granted pursuant to 35 U.S.C. 119 and 365 based upon British Application Nos. 0224749.2, filed October 24, 2002 and 0230211.5, filed December 27, 2002. The International Bureau already should have sent certified copies of the British applications to the United Stated designated office. If the certified copies have not arrived, please contact the undersigned.

Respectfully submitted,
Antony MORTON

Neil F. Greenblum
Reg. No. 28,394

**Robert W. Mueller**
**Reg. No. 35,043**

April 22, 2005
GREENBLUM & BERNSTEIN, P.L.C.
1950 Roland Clarke Place
Reston, VA 20191
(703) 716-1191

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Dated 7 November 2003

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| | |
|---|---|
| 1. Your reference | IAM/LM/P/21688.GB |
| 2. Patent application number *(The Patent Office will fill in this part)* | 0224749.2 — 24 OCT 2002 |
| 3. Full name, address and postcode of the or of each applicant *(underline all surnames)* | Voith Fabrics Heidenheim GmbH & Co KG<br>Kurzestraße 11<br>Heidenheim, D89522<br>Germany |
| Patents ADP number *(if you know it)* | 7841125001 |
| If the applicant is a corporate body, give the country/state of its incorporation | A German Company |
| 4. Title of the invention | Dryer Fabrics |
| 5. Name of your agent *(if you have one)*<br>"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)* | WILSON GUNN M'CAW<br>41-51 ROYAL EXCHANGE<br>CROSS STREET<br>MANCHESTER<br>M2 7BD |
| Patents ADP number *(if you know it)* | 7153927001 |

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

| Country | Priority application number *(if you know it)* | Date of filing *(day / month / year)* |
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| Number of earlier application | Date of filing *(day / month / year)* |
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8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
*a) any applicant named in part 3 is not an inventor, or*
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| Claim *(s)* | | 8 |
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| Priority documents | |
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| Statement of inventorship and right to grant of a patent *(Patents Form 7/77)* | |
| Request for preliminary examination and search *(Patents Form 9/77)* | |
| Request for substantive examination *(Patents Form 10/77)* | |
| Any other documents *(please specify)* | |

11. Wilson Gunn M'Caw

I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 23/10/02

12. Name and daytime telephone number of person to contact in the United Kingdom — Mr Ian Middlemist — 0161 827 9400

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Dryer Fabrics

This invention relates to a fabric for use in a so-called dynamic condensation drying apparatus or other similar condensation drying processes in the manufacture of paper and board.

A dynamic condensation drying apparatus involves the utilisation of a heat source to generate water vapour within the wet web. This leads to an increase in vapour pressure and a thermodynamic drive for such moisture to leave the web.

The moisture is then condensed by cooling, the water then being retained by the fabric to avoid re-wetting of the web. In such dynamic condensation drying apparatus, a hot steam heated solid steel roll or belt is pressed against a moist paper web which is transported on a fine fabric. The fine fabric in turn lies immediately adjacent a coarse fabric. The coarse fabric is located next to a water-cooled solid steel or other composite impermeable belt.

The drying process begins as the paper web contacts the hot steel roll or belt, generating water vapour which passes through the fine fabric. This is collected as it condenses in the voids of the much cooler coarse fabric (as this is in contact with the water cooled belt). The temperature gradient between the two restraining elements, for example the hot and cold steel belts, drives the drying equilibrium, since the more water removed from the gaseous state as condensate in the coarse fabric, the more water can be evaporated into vapour from the web. Air removal from the drying system, and application of physical pressure to the web may also be a feature. The drying rate has been quoted as being typically 5-10 times higher than for cylinder drying, and the hot steel belt or roller may be used at 120° - 180° C, and the cold steel or composite belt at 20°- 90°C.

The fine fabric serves to transmit uniform pressure to the paper web, as it is pressed between the two restraining elements; since a coarse fabric alone would mark the web. The coarse fabric is present to provide plenty of void volume in which water from the web can condense and be subsequently removed.

US 6,397,493 (Voith-Sulzer) discloses one example of a dynamic condensation drying apparatus wherein a steel or composite belt seals the cooling chamber and the paper web is pressed against the heated cylinder by one or more fabrics.

US 5,778,555 (Valmet) discloses a machine and process for carrying out the CONDEBELT (Registered Trade Mark) process, which consists of drying the web between two steel belts, one of which is heated and the other cooled. US 5,706,587 and EP-A-0,727,521 disclose modifications thereof.

EP-A-0,962,588 and 0,962,589 disclose a two fabric arrangement, wherein a fine woven fabric is propelled on the paper side of a coarser fabric, the latter being modified by incorporation on the machine side face of additional finer cross direction yarns in the spaces between the main cross-direction yarns to provide a fine woven surface against the cooled belt.

The term "fabric" as used above and hereinafter in practice refers to web support fabrics which are typically synthetic woven fabrics, although woven metal fabrics or hybrid metal/synthetic woven fabrics or non-woven fabrics, including membranes, may also be used.

The use of a fine and a coarse fabric as in the last example above however presents a number of problems, notably:-

a) A fine top cloth and a coarse cloth under it have been used the vapour passing through the coarse cloth and condensing as the coarse cloth is in contact with

the cold steel surface. The coarse cloth is intended to retain the moisture, but considerable rewet occurred due to capillary action of the fine top cloth drawing water back from the coarse cloth. The cold belt contacting side of the coarse cloth may be made finer by in-filling the weave with additional weft threads, while retaining a two-fabric arrangement as in EP-A-0,962,588 above), which addressed the problem to some extent.

b) The fine structure of the top fabric means that it is not possible to incorporate a seam which can be joined on the paper machine using a pintle wire or any interconnecting technique, since the seam loops will be proud of the paper contacting surface of the fabric and will mark the web, since fine structures involve the use of thin fabrics. As a consequence, the top fabric has to be provided in endless form. To make an endless fabric involves either exceptionally wide and expensive weaving machinery, or the time consuming process of weaving a flat piece of fabric and then rendering it endless in a seaming machine, before delivery to the customer.

Highly complicated cantilevered machine structures are needed to install the top fabric in to such dryer systems. It may take several days to install the fabrics as compared to a number of hours if both of the fabrics were on machine joinable, for example by inserting a pintle wire through the fabric seaming loops or by effecting a join by other means.

c) The presence of two fabrics with different structures, which are simply laid one on top of the other, can lead to interference patterns when they are pressed between the belt and roll or between two belts. This is caused by the coincidence of weave knuckles in the upper and lower belts overlying each other. This interference can mark the web and/or lead to aggravated abrasion between the two fabrics. The latter is a particular problem where the two fabrics diverge at the end of the condenser

belt dryer due to the difference in modulus between the two fabrics. The use of two fabrics also gives rise to problems such as increased wear and abrasion.

An object of the invention is to overcome the problems set out above so far as is possible and to provide a single fabric for transport and dewatering of a paper web through a dynamic condensation drying apparatus as hereinbefore defined.

According to the invention, a dewatering fabric for use in dynamic condensation drying apparatus comprises a three layer fabric. The fabric preferably has a paper contacting surface layer, a core having a high void volume, and a machine side surface layer. The paper contacting surface layer preferably is relatively the finest of the three layers, that is it is comprised of closely spaced yarns or fibres of small diameter. The machine side surface layer is preferably of intermediate fineness, being composed of yarns or fibres of a larger diameter and more loosely spaced than those of the paper contacting surface layer. The high void volume of the core may be provided for example by wide spacing of the constituent yarns or fibres, or by incorporation of a perforated sheet or membrane layer.

The invention makes possible an apparatus with a single dryer fabric for transporting the paper wet through a dynamic condensation drying apparatus or similar installation, in place of the two fabrics heretofore considered necessary.

The finer surface of the paper contacting side serves to provide good support to the web, to allow for high heat transfer due to densely spaced contact points and to help prevent marking of the web. The opposite fine surface which faces the cold belt is preferably not as fine as the web support surface, but is preferably sufficiently fine to encourage the condensed water to remain in the fabric without any tendancy to be drawn back through the structure to cause web re-wetting. To aid this, the core of the fabric may comprise a permeable structure containing relatively large pores with low

capillary force. The fabric preferable comprises a structure with a Young's modulus greater than or at least equal to that of the coarse base fabric in the prior art.

Regions of the fabric may be treated so as to render them more or less hydrophilic to ensure preferential movement of moisture from the heated (web contacting) side to the cooled side.

The fabric may be endless or seamed, and if seamed is preferably capable of being joined on the machine, thereby overcoming many difficulties experienced at present.

The dryer fabric in accordance with the invention will be thicker than the fine fabric used heretofore in the condensation dryer apparatus and thus there will be no associated seaming problems, as the seams need not be lie proud of the surface.

The dryer fabric of the invention may comprise a core of woven base cloth, a single or composite perforated membrane or a spiral-link base cloth, having a batt of staple fibres needled to each side of the base cloth, or alternatively it may be filled with an open-celled foam, or a sintered or otherwise porous synthetic plastics material, which may be proud of the paper contacting side. Such structures can have the advantage of containing relatively large pores with low capillary forces.

The fibrous batt or porous medium may be coated with a resin such as an epoxy, phenoxy, fluoropolymer or silicone, and then perforated. The perforations may be carried out using laser, waterjet, mechanical punching or other cutting techniques or may result from the coating process, e.g. by coagulation chemistry or by transfer coating a reticular coating onto the batt or medium. The latter can give an optimum pore volume, surface tension, contact ratio and smoothness properties.

At least one layer of the dryer fabric may comprise a sintered structure formed from beads, fibres or other particles of thermoplastics, metal or the like, partially

melted and fused together. The sintered structure may also contain a textile reinforcement such as chopped fibres, a woven fabric felt, non-woven fabric, membrane or yarn, at least partially encapsulated in the sintered structure.

At least one layer of the fabric may be a microporous open cell foam coated structure.

The dryer fabric may comprise a laminate of sintered polymer, a coating or a fine staple batt layer, or a composite membrane, supported by a spiral link or other open structure such as a coarse woven base cloth, with a further fine layer on the underside.

Preferably, the fabrics are made from materials with high temperature and hydrolyis resistance, for example PPS, PEEK, PEK, polyamide, fluoropolymer, glass, metal, PEN or PBM. Conventional dryer fabric materials may be used in parts of the fabric which are insulated to a certain extent from the hot felt or roll by the high temperature resistant material. These may include nylon, PET, PBT, PTT, PCTA or polyetheramides (such as Elf Atochem's PEBAX).

The fabric according to the invention may also be used on conventional steam-heated dryer sections or on air-impingement dryer sections. A key requirement of a fabric for a dynamic condensation drying apparatus is to prevent rewetting of the paper web by water already expelled from the web into the fabric. Therefore hydrophobic materials are preferably used to make surface components of the fabric, although hydrophilic materials are of advantage in the lower regions away from the paper contacting surface, in order to provide good water storage capacity.

Some embodiments of the invention will now be described by way of example with reference to the accompanying drawing, wherein:-

Fig. 1 is a diagram showing a fragmentary cross-section of a part of a condensation drying apparatus;

Fig. 2 is a sectional view of a first embodiment of dryer fabric according to the invention;

Fig. 3, 4, 5, 7, 8 and 9 are sectional views of further embodiments of dryer fabric according to the invention; and

Fig. 6 is a fragmentary perspective view of a yet further embodiment of dryer fabric according to the invention.

Figure 1 is a diagrammatic sectional view of a roll in a dynamic condensation drying apparatus. This is a magnified view of part of the shell of the roll with superposed dryer and carrier belts, with the curvature exaggerated. The outer wall of the roll comprises a shell or steel surface 11, which is heated from within the roll. A paper web 10 is passed over the roll in contact with the heated shell 11, with a drier fabric 13 pressing it thereon. The dryer fabric also serves to transport the paper web 10, and to absorb moisture driven from the web 10. Belt 12 is exposed to lower temperatures on its outer-side. This may be by contact with ambient air, forced ventilation, or actively refrigerated air, or more preferably a reservoir of cooled water, which is sealed by belt 12. The heated surface of cylinder 11 is between the range 120°C - 180°C, whilst the belt 12 is maintained in the range 20-90°C, that is below boiling point so that condensation can take place.

In the remaining figures several examples of dryer fabrics 13 are shown in diagrammatic cross sections.

Figure 2 illustrates a preferred embodiment of dryer fabric in a dynamic condensation drying apparatus. The fabric 20 consists of laminated, superposed, needled together, or interwoven woven fabric layers, comprising a fine mesh woven

layer 21 on the paper contacting side of the fabric (i.e. towards the heated roll), a core comprised of a coarse mesh woven layer 22, and a further woven layer 23 on the reverse side of the fabric, contacting the impermeable belt 12, and towards the cooled side of the apparatus. The layer 23 is normally less fine than layer 21, but significantly less coarse than the core layer 22.

A further embodiment is illustrated is Fig 3. In this, a fabric 30, comprising a fine two-ply woven fabric 31 is provided on the paper contacting side of the composite fabric. This is supported by a core 32 of a coarser weave base cloth, with a fine fibre batt 32 on the reverse side of the fabric, to contact the cooled impermeable belt 12.

Figure 4 shows a yet further embodiment of fabric 40 wherein a batt 41 of finer fibres is provided on the paper contacting face of a core comprising a woven support fabric 42. A further batt 43, predominantly of coarser and higher density fibres is provided on the cooled impermeable belt side of the fabric 40 (the lower side in the drawing).

In Figure 5, the fabric 50, which includes a paper contacting membrane layer 51 and a cooled belt contacting side membrane layer 52. The membrane layers 51, 52 are separated by at least one core layer 53. Membrane layer 51 is provided with relatively fine perforations or pores 54 of relatively small diameter which are also relatively closely spaced. The membrane layer 52 includes perforations 55 which are of larger diameter than the perforations in the layer 51. The percentage of void spaces in the two membrane layers may be equal or approximately equal, or the percentage of void space in the layer 52 may be greater than that in layer 51.

The core layer 53 has a higher percentage of void space than either of the membrane layers and includes a network of interconnecting passageways to assist the

through passage of water. In the embodiment shown this is achieved by making the layer 53 from a mass of particles of thermoplastic material which are firmly fused under light pressure to adhere at their tangential surfaces and at the same time leaving considerable space between the particles.

The particles may be generally spherical or oblate, or cylindrical (e.g. formed by closely chopping yarns or fibres), or irregular.

The above observations concerning the incidence of void space in the outer and inner layers of the various dryer fabric structures is applicable to all the particularly described embodiments of the invention mentioned both above and herinafter.

Figure 6 shows an example of fabric 60 with a foramines honeycombed structure 63, comprising a top membrane layer 61 with small apertures, and a bottom membrane layer 62, with large apertures and the honeycomb membrane 63 sandwiched therebetween.

The top layer 61 is the paper web contacting layer, and the bottom layer 62 contacts the cooled impermeable belt 12.

In figure 7, a fabric is shown comprising more than three layers, and this comprises a base cloth 70 of a coarse woven fabric which provides sufficient void volume and supports a composite membrane comprised of two or more superimposed layers 71; 72; each layer 71, 72 has differently sized and spaced apertures 73, 74. The layer having the greater void spaces preferably adjacent the base cloth 70. The composite membrane carries a layer 75 of sintered thermoplastic particles which form the paper contacting layer. A further layer 76, comprising a nonwoven batt of fine fibres is provided below the base cloth 70. The extensibility of this batt may be equal to or less that 1% in the machine direction under a load of 10kg/2.5cm, at 20°C.

In figure 8, the fabric comprises a fibrous batt 80 of staple fibres on the paper side is needled into a spiral link base cloth 81, and a second batt 82 of fine fibres below the base cloth 81. In variations of this embodiment, either or both of the batts may be surfaced with a resin such as an epoxy, phenoxy, fluoropolymer or a silicone and/or the link base cloth filled with a foam plastics material.

Finally, in Figure 9, a spiral link fabric core 90 has plastics coating 91 on the paper contacting side, this coating penetrating about a third of the way into the spiral link fabric e.g to the level of the cross machine direction hinge yarns, which hold the links together. In this embodiment a fine fibrous batt layer 92 is provided on the belt face of the link fabric.

The paper contacting surface of the above descended embodiments can be rendered microporous by coating with a fluoropolymer , silicone, epoxy or phenoxy resin, which may be coagulated to form a microporous skin, or a reticulated coating may be transferred onto the batt or other surface medium.

The fabrics of the invention provide void space within the belt; and also help to prevent rewetting of the web by provision of a fine layer in contact with the cooled condensing belt 12, drawing moisture away from the web by capillary action.

Fig.1

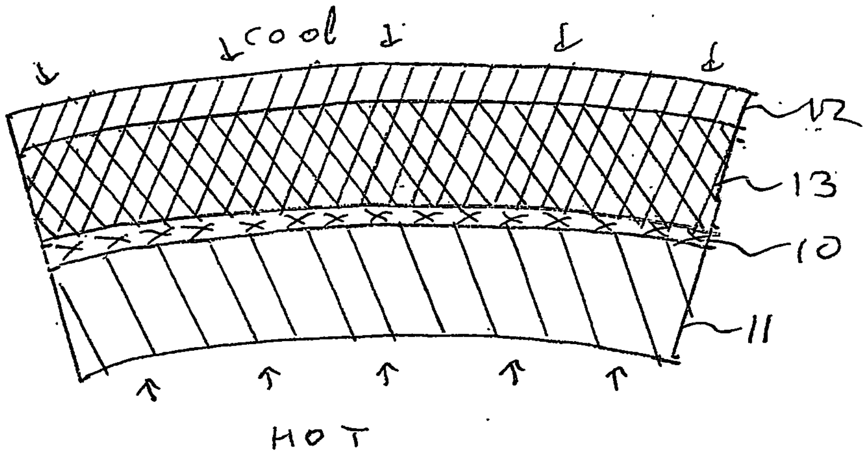



Fig.2

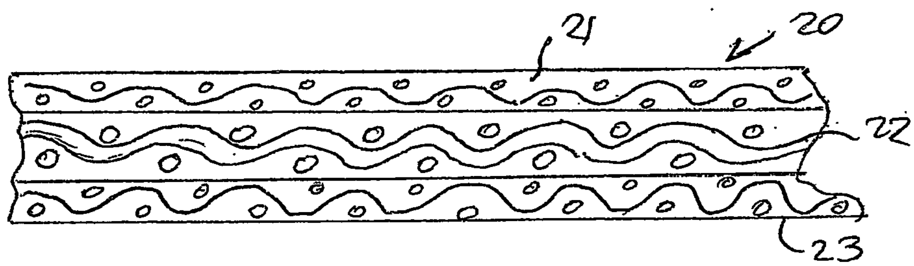



Fig.3

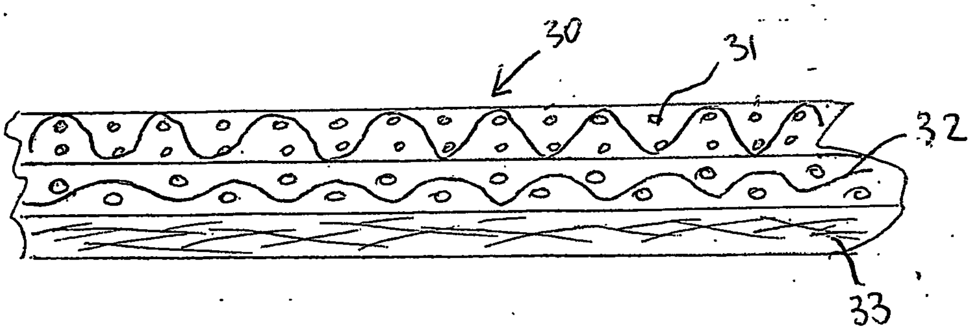



Fig.4

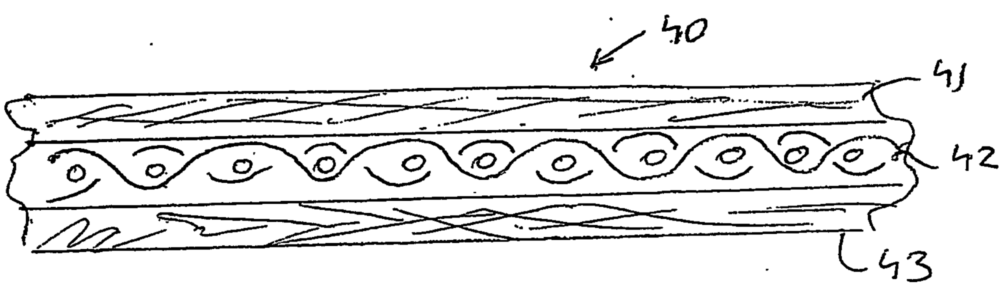


Fig. 5.

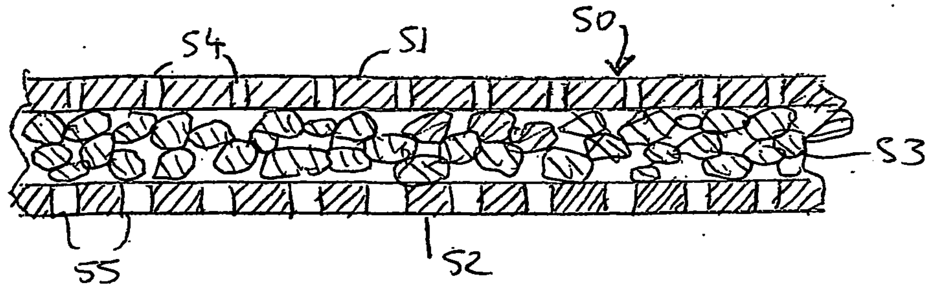



Fig. 6.

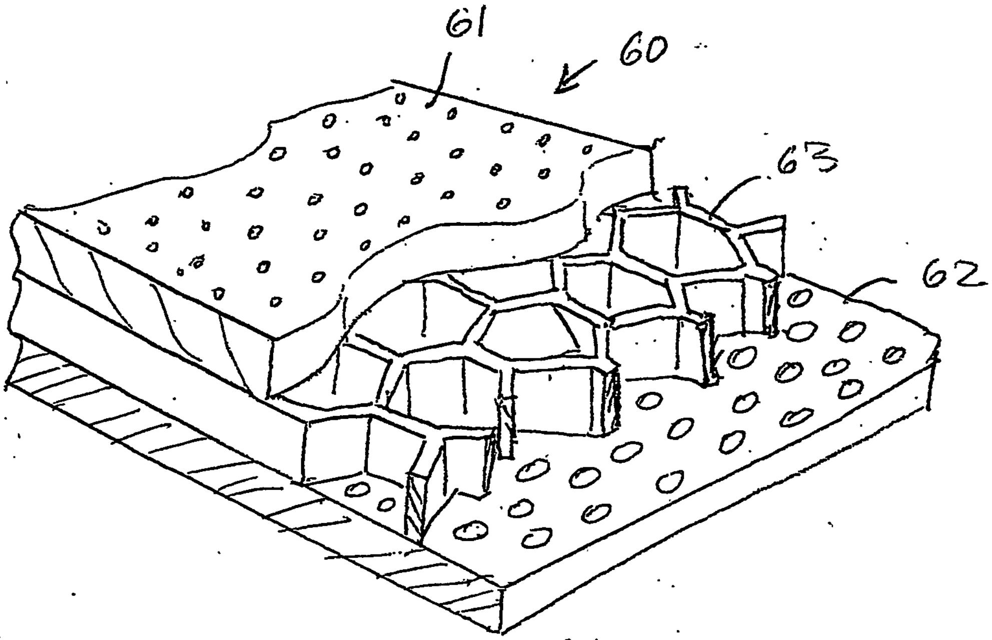



Fig. 7

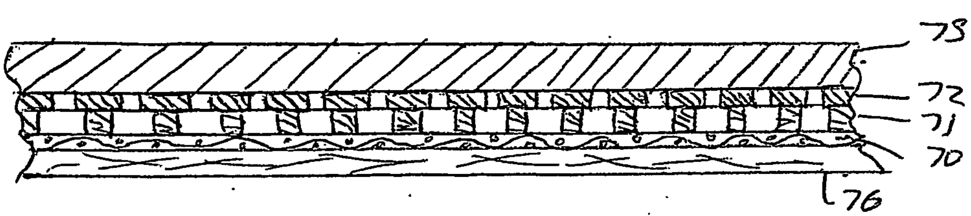



Fig. 8

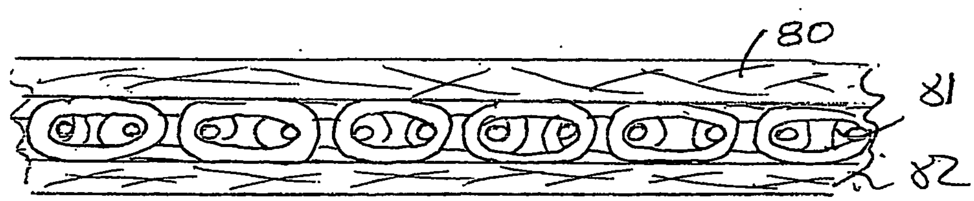
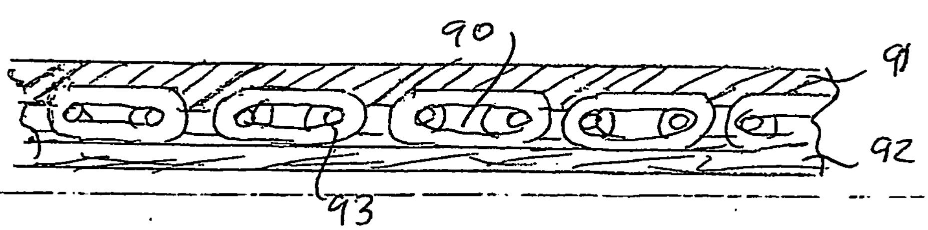



Fig. 9



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